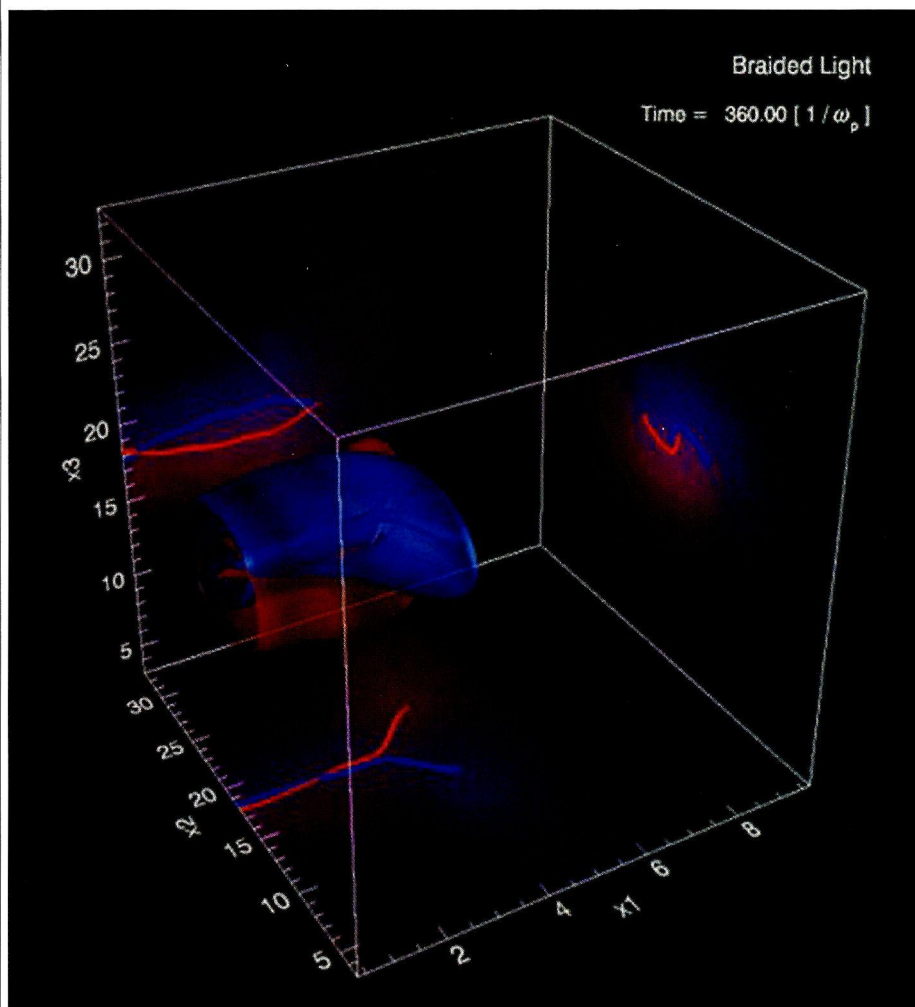


Lasers create braids



A simulation showing how in a special plasma environment two beams can braid around each other. The blue and red lines show the calculated centroids for two laser beams. The lines on the box walls are projections of the centroids for the three dimensions.

Intense laser beams travelling in a plasma twist around each other to form a braid of light, say UCLA physicists. Although Maxwell's equations state that light beams in a vacuum do not interact, in a nonlinear medium such as a plasma there is a self-interaction, principally generated by relativistic mass corrections.

Starting from the Schrodinger equation, with added nonlinearity, the physicists calculated that the beam centroids of two gaussian laser pulses would move like point particles with a mass proportional to the power of each pulse. The force between the pulses is always attractive and depends on the beam spot

sizes; as the beam separation increases, the spiralling period increases exponentially.

The braiding effect happens because the beam tails rotate faster than the heads. This is partly due to the smaller beam spot size in the tail, but the researchers also noticed a significant contribution from Raman scattering, as the tails get caught in the wake of plasma waves. Experimental studies are now underway in California and Portugal, with the prospect of future application in optical steering. The braiding effect might also occur when streams of photons emanate from supernovas and gamma-ray bursters.

AIP

Electro-optical effect detects particles

Brookhaven physicists have demonstrated that charged particle beams can be detected by the electro-optical effect induced in optical crystals.

This ultrafast mode of particle detection is based on birefringence produced in an optical medium by an electrical field: the anisotropy of refractive index in the medium means that for orthogonal components of polarization, the velocity of propagation is different – a phase difference will develop, such that light that was originally linearly polarized will now appear elliptically polarized.

Using a photodiode, the researchers traced the modulation of transmitted laser light in an LiNbO₃ crystal and measured the induced ellipticity as a 1 mm diameter 45 MeV electron beam, carrying up to 1 nC in 10 ps bursts, passed within a few millimetres of the crystal. The ellipticity can then be directly related to the electric field of the charged particle beam.

The team suggest these results will lead to the construction of beam profile detectors with excellent time resolution based on parallel rows of LiNbO₃ crystals, and that even single particle detection could be achieved with this technology.

Nucl. Inst. Meth. A

Want to write for the Courier?

With Alison Wright moving on to higher things, CERN Courier is looking for someone to edit its popular Physicswatch news feature. Physicswatch monitors current developments outside the particle and nuclear physics, astrophysics and astronomy sectors covered in the rest of the magazine, particularly in areas of potential interest to specialists in accelerators and detectors.

The post is unpaid, but is a good opportunity for a trained physicist to exploit their interest in science communication and journalism. The Physicswatch Editor would work in close collaboration with the Editor of CERN Courier.

For more information, see past issues ("http://www.cerncourier.com") or contact the Editor at "gordon.fraser@cern.ch".

Crystal defects aid optical communications

Scientists in Japan have demonstrated a new device that could lead to the development of all-optical circuits. This verifies predictions that photons can be manipulated inside photonic crystals (May p9) by introducing particular defects in the photon bandgap structure.

In a photonic crystal, the dielectric constant of the material varies periodically, so certain frequencies of electromagnetic radiation cannot propagate. Making a strip of defects in the crystal forms a path for "forbidden-frequency"

waves, and the crystal becomes a waveguide.

On a thin slab of just such a waveguide (a 0.25 μm InGaAsP layer on an InP substrate), the researchers introduced another crystal defect close to the forbidden-frequency path. Usually photons cannot escape the two-dimensional waveguide because the refractive index of the air above and below the plane is very different to the refractive index of the material. However, the extra defect acts as a coupler from the in-plane to the vertical

direction – photons propagating through the waveguide are trapped by the defect, which then efficiently emits them into free space. The defect acts as an optical resonator, with a resonant frequency determined by the size of the defect and the lattice constant of the photonic crystal.

The researchers expect that, thanks to its small size and flexibility, their new device will have an enormous impact on global communications networks.

Short-pulse lasers lead to tabletop positrons

Experiments at the Max Planck Institute for Quantum Optics at Garching, near Munich, have shown how positrons can be generated by high-power, short-pulse laser beams.

The femtosecond time intervals obtainable with modern lasers can probe the "evolution" of very fast processes. Ahmed H Zewail of Caltech was awarded the 1999 Nobel Prize for

Chemistry for showing how such techniques can be used to study how atoms take part in chemical reactions.

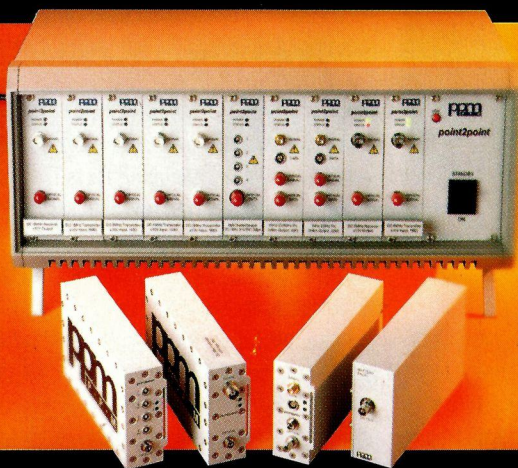
High-power laser pulses can also rip electrons from atoms, and the giant Petawatt laser at Livermore has shown how these electrons can create gamma rays which in turn can make electron-positron pairs when they hit a

2 mm lead converter. The energy of the positrons is a few mega-electron volts.

The authors say that the advent of positron production using femtosecond laser pulses could lead the way to tabletop positron sources for applications in material science.

Femtosecond lasers have also been used to drive synchrotron radiation (July p31). AIP

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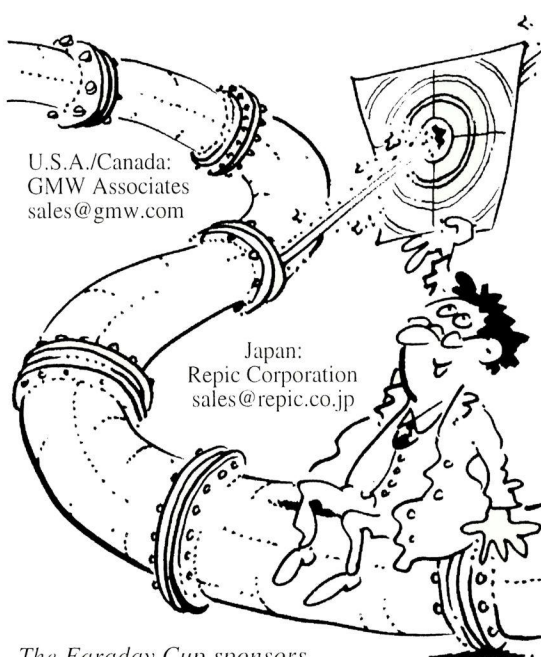
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